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Mineral and Feeding Values of Two Cultivars of Guinea Grass (*Panicum maximum*) as Influenced by Soil Type in the Derived Savanna Zone of Nigeria

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Abstract: Two cultivars of *Panicum maximum* (cultivars T58 and Ntchisi) were evaluated to determine the influence of soil type(texture and class) on their mineral and feeding values. The grasses were planted at two different locations on the farm site. Results shows that those planted on the sandy loam soil performed best. The grasses were not able to withstand the presence of clay at all. The number of tillers produced in the sandy clay soil was lower (4,250 kg ha^{-1}) than the one in the sandy loam soil (5,826.5 kg ha^{-1}). The presence of clay influenced the minerals present and especially made most other minerals not really available to the plant. The soil types affected the grass feeding value. The pH of the soil had no influence on the dry matter productivity of these grasses, but determined the level of acidity or basicity of the soil and had a direct link to the type and available minerals at any particular time.

Key words: Feeding value, guinea grass, mineral, soil type

INTRODUCTION

Soils, as products of weathering of basal rocks, are the natural media supporting land plants and supplying water and thirteen of the sixteen essential elements to plants (Miller and Donahue, 1990). A few plants benefit from the addition of a few elements, which are also derived from the soil. In the process of providing and supplying these plants needs, the physical and chemical soil properties can exert dominant influences. The physical properties include soil texture, structure, aeration, mineralogy, temperature and water relationships in the soil (Raymond Miller, 1994). Chemical properties include the soil pH, the concentration of the available nutrients, the presence of toxic concentrations of certain elements, the amount of humus and the chemically active mineral surfaces that absorb organic substances and soluble ions (Tisdale *et al*., 1993).

Pasture and range survive and produce well on optimum soil nutrient. However, tropical grasses are generally lower in nutritive value that temperate grasses of comparative age (McDowell *et al*., 1984). Pasture plants in Nigeria are low yielding, of poor quality and inefficiently utilized (Oke Agu and Akintala, 1982). Nonetheless, ruminants rely more profitably on pasture for their nutrient requirement than on any other feed resources. It has been documented that the soil type in the temperate region contributes immensely to the productivity of their pasture plants and animal growth ˙. The low productivity in tropical pastures is a function of the deficiency of nitrogen in most tropical soils and nitrogen play an important role in pasture growth, development and production.

Mineral elements are very vital to the animals metabolic processes. Grazing livestock from tropical countries often do not receive mineral supplementation except for common salt. They depend almost exclusively upon forages for their mineral requirements (McDowell *et al*., 1984). Mineral deficiency in soil and forages account partly for the low animal production and reproductive problems.

Panicum maximum, a tropical grass specie, has adapted to a wide range of soil conditions and performs well in area receiving 800-1800 mm annual rainfall and with a dry season of less that 4 month (McCosker and Teeitjel, 1975; Bogdan, 1977; Whiteman, 1980). In the tropics, especially in Nigeria, *Panicum maximum* has been well researched in the southern Nigeria (NRC, 1975), Northern Nigeria (Blair Rains, 1963) and southwestern zone of Nigeria (Ademosun, 1973). There is however a paucity of

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information on *Panicum maximum* in the derived guinea savanna zone where ruminant production is most favoured in Nigeria.

This study was therefore conducted in Ogbomoso (in the derived savanna zone of Nigeria) to evaluate the productivity of the *Panicum maximum* and to ascertain its soil requirements.

MATERIALS AND METHODS

Site: The experimental plot was sited at the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, located in the derived savanna zone of Nigeria. Ogbomoso lies at approximately 8°7"North of the equator and 4°15" East of Greenwich meridian. The climate is characterized by a fairly high uniform temperature (36.20°C), moderate to heavy seasonal rainfall (1247 mm annually) and high relative humidity. The natural vegetation is considered to be low land rain forest but under the influence of high agricultural activities comprising a bush fallow system of farming little high forest remains. Therefore, it is regarded as a derived savanna vegetation zone because grassy vegetation has followed the clearing of land and cultivation (Oguntoyinbo, 1978).

Experimental design: Two cultivars of *Panicum maximum* (T58 and Ntchisi) were planted using a completely randomized design on a 50×50 cm spacing at two different locations on the farm. Each cultivar was replicated three times. Growth pattern of these grasses in relation to the soil type was studied measuring these parameters; proportions of sand, silt and clay, the shape and porosity of masses of soil particles cemented together, the ease of air exchange into the soil, the kinds of minerals in the soil, the pH, the concentrations of available nutrients and the toxic levels of these nutrients. The soil characteristics were studied both before and after planting. At harvest, grasses were cut 15 cm above ground level and samples collected, oven dried at 80°C for 72 h and analyzed to determine the chemical constituents on dry matter basis.

Chemical analysis: Chemical analysis of the soil and grass was done to determine the nutrient levels. Soil texture which determines the sand, silt and clay proportions was evaluated by measuring how clayey or sandy the soil is. This was done by feeling the soil sample with the fingers when dry and as water was added gradually. Laboratory measurements were readily done by amounts of soil particles that settle out of a water suspension after various times. Sand sizes were further indicated to determine the sand loam fractions.

Soil structure i.e., shape of soil particles were studied on site of planting and classified as platy, columnar, cubical spherical. Soil available nutrient was studied (i.e., soil testing) using different standard chemical methods (AOAC, 1990).

The optimum levels of these minerals were determined and serve as guide to fertilizer application. The levels of the heavy metals were determined (Cu, Zn) to make sure that the animals are not exposed to dangerous plants and soil.

Statistical analysis: All data collected where analyzed using (SAS, 1998) and means compared using Duncan New Multiple Range Test at 5% probability level.

RESULTS AND DISCUSSION

Soil texture is a controlling plant growth factor. It is a measure of how clayey or sandy a soil is. *Panicum maximum* cultivars T58 and Ntchisi were discovered to perform best in a sandy loam soil but with a higher loam content for cv T58. The two cultivars were not able to perform well in a clayey environment. As documented by Whiteman (1980), Holm *et al*. (1977). *Panicum maximum* is adapted to a wide range of soil but not clayey soil. Oke Agu and Akintola (1982), Crowder and Chheda (1982), Chheda and Akintala (1971) also documented in that the grass performed best in a well drained, light textured sandy loam or sandy-clay soil but that it cannot withstand waterlogged heavy clay soil situations. These cultivars of guinea grass performed best in a sandy loam soil in this ecological zone. The sand size and coarse fragments present in this area were able to control the soil water movement, water retention capability and increased the till ability of the soil.

Pre-sowing soil sampling showed that the pH (H_20) of the soil (6.0) was higher than what was observed after planting for cv Ntchisi. However, a higher pH (6.2) was recorded for the cv T58 plot (Table 1). This suggests that because of the loss in water content of the soil, it tended slightly towards the acidic side showing that soil moisture helps to maintain soil pH for optimum plant growth. These soil types are not readily leached, therefore, acid or mineral toxicity is not a possibility in the environment (Raymond Miller, 1994). The soil nitrogen and organic matter content increased after cultivation. This agrees with (Dick *et al*., 1988) that accumulation and decomposition of organic material through tillage and proper mixing in the soil increase the organic matter level. The organic matter content has a direct relationship with the nitrogen level. It helps to improve soil structure and texture and invariably increases plant productivity in

Table 1: Pre and post-planting soil chemical characteristics for *Panicum maximum* cv T58 plot

Properties	Pre-planting	Post planting
PH (H_20)	6.0	6.2
Organic carbon (%)	0.44	0.73
Total N (%)	0.04	0.07
Available P (%)	3.81^a	2.86^b
Ca	2.30^b	3.40^a
Mg	0.59^b	0.92^a
Na	0.17	0.17
K	0.19	0.22
CEC	3.70^b	5.03^a
Base saturation	87.84^b	93.64^a
Cu	0.34^b	0.60^a
Zn	2.3	2.6
Mn	41.3	42.7
Fe	6.1^a	3.3^b

a, b means in the same row with different superscripts are significantly different at p<0.5

Table 2: Productivity and feeding value of 2 cultivars of *Panicum maximum* at 12 weeks of age

Parameters	CV T58	CV Ntchisi
Dry Matter Yield (kg ha^{-1})	2226.5^b	2528.8^a
Tiller Height (m)	0.88^b	0.96^a
Tiller Number	295^b	302^a
Leafiness	90^b	92^a
Crude Protein	8.18^b	7.78^b
Crude Fibre	37.5^a	35.6^a
NFE	69.1^b	68.9^a
Ash	13.2^b	14.5^a
Phosphorus (%)	0.13	0.15
Ca	0.16	0.71
Mg	0.04	0.04
K	0.08	0.07
Mn (mg kg^{-1})	43.45	44.55
Fe (mg kg^{-1})	104.05	112.04
Cu (mg kg^{-1})	3.9	2.8
Zn (mg kg^{-1})	41.50	42.35

a, b means in the same row with different superscripts are significantly different at p<0.5

terms of dry matter production and the crude protein content. This agrees with Galloway and Cowling (2002) that nitrogen serves as the pivot of life upon which all life processes and maintenance depend.

Available phosphorus decrease after planting. Phosphorus is a mineral element very responsive to nitrogen alteration but easily depleted from the soil because of its role in seedling growth and seed production (Raymond Miller, 1994). Therefore, artificial nitrogen supplementation of the soil is a thing of necessity to maintain the nitrogen levels at high values to keep the phosphorus level high (Olumoya, 1998).

Increased soil fertility was observed to cause an increase in the Cation Exchange Capacity (CEC) values. This is because the sand content of the soil decreased because of a higher rate of organic matter decomposition after cultivation. According to Raymond and Miller (1994) soil CEC tends to be highest in organic soils, low in sandy soils and also high in clay soils. As the level of organic content increased, the CEC value was higher which confirms the work of Raymong Miller (1994), Tisdale *et al.* (1993) that CEC has the highest value in organic soils. Because elements like calcium, magnesium, sodium, potassium and aluminum are positively correlated to the CEC value as observed by Raymond Miller (1994), the values/levels of these mineral elements were also found to increase. The increase in the levels of these cations, especially magnesium tends to suggest that there is the possibility of magnesium toxicity. However, before this can be ascertained, the amount absorbed must be studied. This information will however help to direct the use of fertilizers such as potassium and ammonium fertilizers, which have the ability of replacing these cations in the soil.

In Table 2 at 12 weeks, the pasture grass had a Dry Matter productivity (DMY) of 2226.5 kg ha^{-1} for cv T58 and 2528.8 kg ha^{-1} for cv Ntchisi, which were considerably high (for a grass without fertilizer application). The chemical constituents met the minimum nutritional requirement for ruminant feeding (NRC, 1975). This is slightly opposed to the works of (Akengbe, 1999; Ayinde, 1999) who reported yields of 5228.5 kg ha^{-1} DMY and 6258.7 kg ha^{-1} DMY for cv T58 and Ntchisi, respectively in response to different nitrogen treatments. This tends to suggest that the type of soil in this area can produce enough feedstuff for both wet and dry season feeding, but the amount available was not at its optimum level. Without fertilizer application therefore, these cultivars of *Panicum maximum* can provide a reasonable number of tillers but which will not be able to meet up with the dry season feeding demand. This agrees with the works of (Chheda and Akintala, 1971) on grass productivity for dry season feeding.

The crude fibre content of the grass at this time was considerably high. This may be due to the fact that the pH (H_20) was lower and the soil moisture level was lower. This invariably had an effect on the amount of soluble carbohydrates and an increase in the amount of insoluble parts (lignin, cellulose and hemicellulose) of the leaves. This agrees with (Peaz and Gonzalz, 1995) that water (soil moisture) plays an important role in the photosynthetic pathway. Looking at the effect of the soil type on the mineral elements examined, it was discovered that, without any extraneous factors like fertilizer application, legume intercrop and water control, the soil in this environment will not be able to meet the minimum mineral requirement for sheep production for some minerals like phosphorus that had 0.13 and 0.15% for cultivars T58 and Ntchisi which were , respectively below suggested values of 0.16-0.37% by (NRC, 1975).

Of particular interest were the potassium and magnesium levels. The level of potassium in the plant (0.07-0.08%) was found to be higher than the 0.05%

Table 3: Pre and post-planting soil chemical characteristics for *Panicum maximum* cv Ntchisi plot

Properties	Pre-planting	Post planting
PH (H_20)	6.2	5.8
Organic Carbon (%)	0.50^b	0.71^a
Total N (%)	0.06	0.07
Available P (%)	3.30	3.35
Ca	2.30^b	3.35^a
Mg	0.57	0.55
Na	0.15	0.16
K	0.17^b	0.20^a
CEC	3.95^b	4.76^a
Base saturation	89.60^b	92.85^a
Cu	0.41^a	0.38^b
Zn	2.20	2.40
Mn	42.5^b	45.5^a
Fe	28.2^a	14.5^b

a, b means in the same row with different superscripts are significantly different at $p<0.5$

recommended by (NRC, 1975). The magnesium level met the 0.04 minimum level for sheep. Niwe and Kom (1988) reported similar values for ruminant production in this area.

The copper levels were lower (3.9, 2.5 mg kg^{-1} for T58 and Ntchisi, respectively) than the minimum level of 5 mg kg^{-1} but the manganese and zinc levels were adequate shown in Table 3. These agree with the report of Olumoya (1998), Ikhimoya and Olaguniu (1996), Osinubi (2004) who observed slightly higher values for manganese and zinc in their studies. However, these levels were not toxic to the animals.

CONCLUSION

Soil type and characteristics affect plant productivity and chemical components to a large extent. Like most tropical soils, the soil type in this environment will need to be improved upon in order to increase the productivity of the plant.

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